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(54) **ULTRA THIN LIGHT SCANNING APPARATUS FOR PORTABLE INFORMATION DEVICE**

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H04N 1/00 (2006.01)
G06F 3/042 (2006.01)

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CPC ***H04N 1/02815*** (2013.01); ***G06F 3/0304*** (2013.01); ***G06F 3/042*** (2013.01); ***H04N 1/00522*** (2013.01); ***H04N 1/02825*** (2013.01); *G06F 2203/04109* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

Disclosed is an ultra thin optical scanning device for a portable information device, which includes an LED as a light source and totally reflects light from an object-side surface to form an image, thereby increasing a contrast ratio of the image and improving the resolution thereof. The ultra thin optical scanning device includes a light emitting device that emits light for sensing an object, an object-side surface contacting the object and totally reflecting the light emitted from the light emitting device, an image formation part collecting the light totally reflected by the object-side surface, and transmitting the light, and a light receiver part forming an image by using the light transmitted by the image formation part.

16 Claims, 3 Drawing Sheets

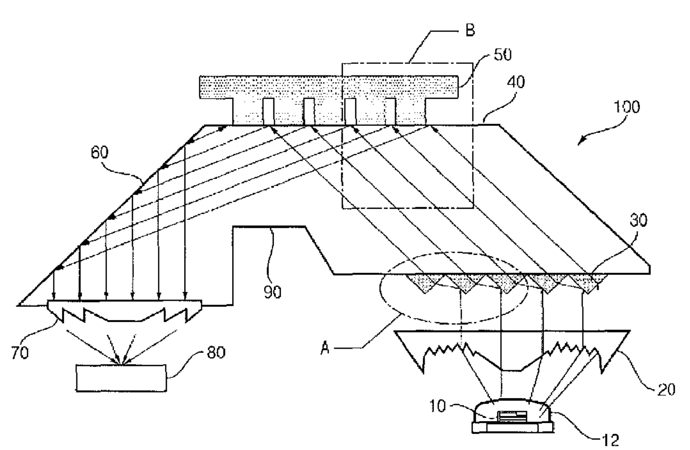


Fig. 1

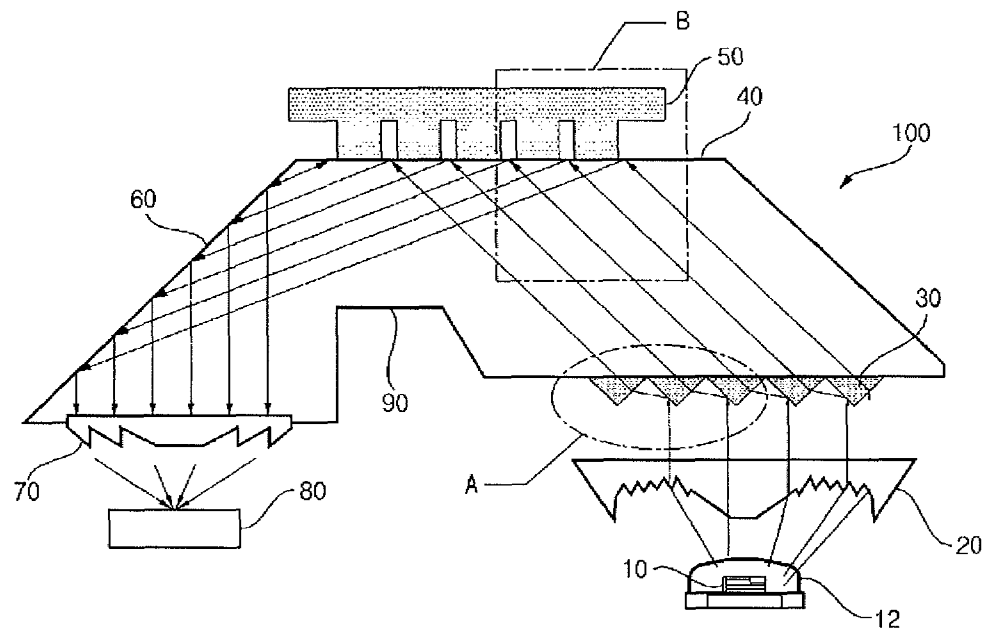


Fig. 2

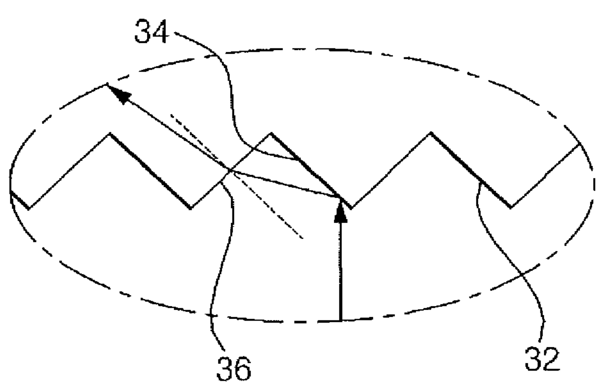


Fig. 3

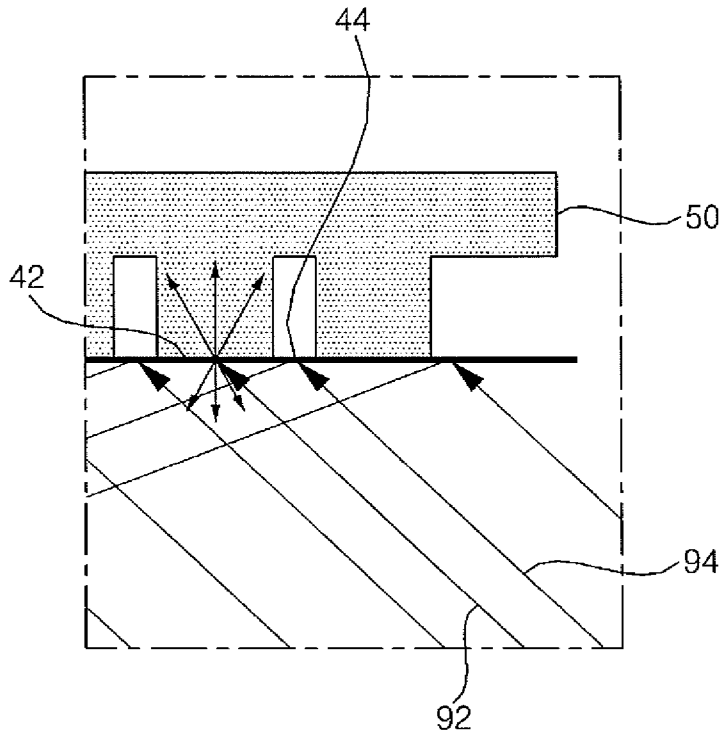


Fig. 4

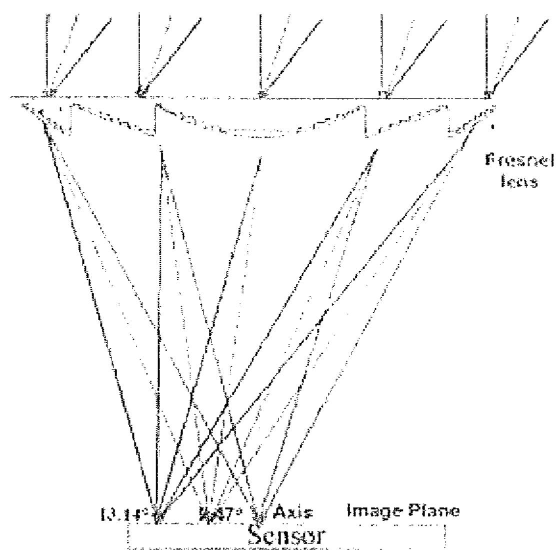
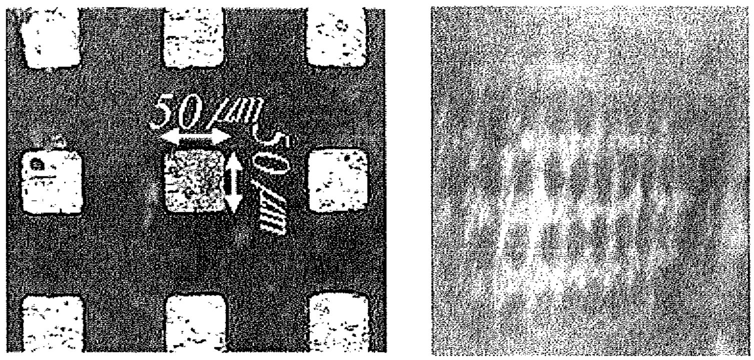
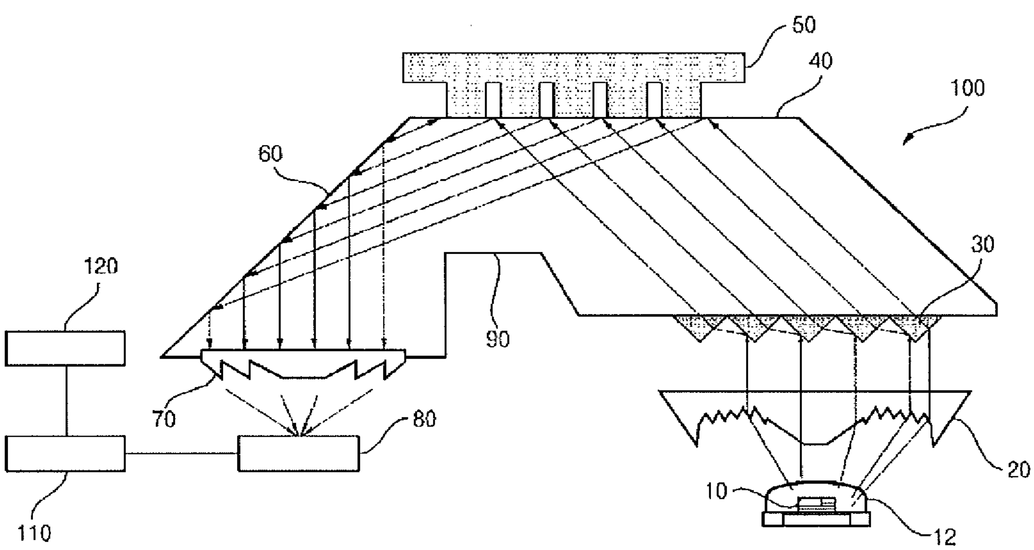


Fig. 5



(a) (b)

Fig. 6



ULTRA THIN LIGHT SCANNING APPARATUS FOR PORTABLE INFORMATION DEVICE

TECHNICAL FIELD

The present invention disclosed herein relates to an optical scanning device, and more particularly, to an ultra thin optical scanning device including a light emitting diode (LED) as a light source and totally reflecting light from an object-side surface to form an image, thereby increasing a contrast ratio of the image and improving the resolution thereof.

BACKGROUND ART

Small information devices may receive information through a keypad and be controlled through the keypad. Input methods using a keypad are sufficient for limited and simple functions of typical information devices, such as input of a phone number or transmission of a text.

Recently developed optical scanning devices recognize a fingerprint or a bar code for improving user convenience and security. For example, a small pointing device using a finger skin is disclosed in Korean Patent Publication No. 10-2005-0002463. Light, emitted from a light emitting device, passes through a transparent plate through an incidence surface thereof and arrives at an object located on an opposite surface of the transparent plate to the incidence surface. Then, the light is reflected from the object. The light reflected from the object is transmitted to a light receiver part through a lens. As a result, the light receiver part recognizes an image of the object.

However, such typical optical scanning devices use an infrared LED and form an image using light absorbed and scattered by an object-side surface. Thus, a contrast ratio of an image formed at the light receiver part is low, which makes it difficult to obtain high resolution.

DISCLOSURE

Technical Problem

The present invention provides an optical scanning device and an optical pointing device including the optical scanning device, which uses total reflection to minimize the loss of light emitted from a light emitting device, thereby obtaining a high contrast ratio that improves the resolution of a scan image.

Technical Solution

In accordance with an exemplary embodiment of the present invention, an ultra thin optical scanning device for a portable information device includes: a light emitting device that emits light for sensing an object; an object-side surface contacting the object and totally reflecting the light emitted from the light emitting device; an image formation part collecting the light totally reflected by the object-side surface, and transmitting the light; and a light receiver part forming an image by using the light transmitted by the image formation part.

The ultra thin optical scanning device may further include a condensing lens that collects the light emitted from the light emitting device, and emits the light in parallel to an optical axis. The condensing lens may be a Fresnel lens.

The ultra thin optical scanning device may further include an optical path changer part that guides a path of the light emitted from the light emitting device, to the object-side surface. The light guided to the object-side surface by the optical path changer part may form an incidence angle such that the light is totally reflected from the object-side surface. The object-side surface, the image formation part, and the optical path changer part may be integrally formed with a main body.

The light emitting device may be a light emitting diode (LED), particularly, a blue LED.

The ultra thin optical scanning device may further include a re-reflection surface that totally reflects the light totally reflected by the object-side surface, to the image formation part. The object-side surface, the image formation part, and the re-reflection surface may be integrally formed with a main body.

The image formation part may be a Fresnel lens or an array lens.

An assembly guide may be disposed in a side portion of the main body.

In accordance with another exemplary embodiment of the present invention, an ultra thin optical pointing device for a portable information device includes: a light emitting device that emits light for sensing an object; an object-side surface contacting the object and totally reflecting the light emitted from the light emitting device; an image formation part collecting the light totally reflected by the object-side surface, and transmitting the light; a light receiver part forming an image by using the light transmitted by the image formation part; a calculation part detecting a movement of the object by using the image, to calculate a coordinate value; and a display part displaying a pointer according to the calculated coordinate value.

The ultra thin optical pointing device may further include a condensing lens that collects the light emitted from the light emitting device, and emits the light in parallel to an optical axis.

The ultra thin optical pointing device may further include an optical path changer part that guides a path of the light emitted from the light emitting device, to the object-side surface. The object-side surface, the image formation part, and the optical path changer part may be integrally formed with a main body.

The ultra thin optical pointing device may further include a re-reflection surface that totally reflects the light totally reflected by the object-side surface, to the image formation part. The object-side surface, the image formation part, and the re-reflection surface may be integrally formed with a main body.

Advantageous Effects

According to the present invention, since light emitted from a light emitting device is totally reflected from an object-side surface, the loss of the light is minimized. Thus, even when the light emitting device has a small capacity, a large area can be sufficiently scanned.

In addition, light refracted and scattered by the object-side surface is not used to form an image, and only totally reflected light is used to form an image. Thus, an image formed according to the present invention has a higher contrast ratio and higher resolution than those of an image formed in the prior art.

In addition, an optical path changer part, the object-side surface, a re-reflection surface, and an image formation part are integrally formed with a main body, and a guide recess is formed in the main body. Thus, an assembly tolerance that may occur during an assembly process can be decreased, and work efficiency can be improved.

In addition, since the image formation part includes an array lens, the image formation part has a short focal length and copes with a large scan region, which makes it possible to miniaturize an optical scanning device.

DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic view illustrating a configuration of an optical scanning device according to an embodiment of the present invention.

FIG. **2** is an enlarged view illustrating a portion A of FIG. **1**.

FIG. **3** is an enlarged view illustrating a portion B of FIG. **1**.

FIG. **4** is a schematic view illustrating a case that an image is formed on a light receiver part of an optical scanning device according to another embodiment of the present invention.

FIGS. **5**A and **5**B are images illustrating an object scanned by an optical scanning device and a scan image thereof, according to the present invention.

FIG. **6** is a schematic view illustrating a configuration of an optical pointing device including an optical scanning device according to the present invention.

BEST MODE

Preferred embodiments of the present invention will be described below in detail with reference to the accompanying drawings. In the following description and attached drawings, like elements are substantially denoted by like reference numerals, even in the case that they are illustrated in different drawings. Moreover, detailed descriptions related to well-known functions or configurations will be ruled out in order not to unnecessarily obscure subject matters of the present invention.

FIG. **1** is a schematic view illustrating a configuration of an optical scanning device according to an embodiment of the present invention. FIG. **2** is an enlarged view illustrating a portion A of FIG. **1**. FIG. **3** is an enlarged view illustrating a portion B of FIG. **1**.

Referring to FIG. **1**, an optical scanning device according to the current embodiment may include: a light emitting device **10** that emits light to sense an object **50**; a condensing lens **20** that collects the light emitted from the light emitting device **10** and emits the light in parallel to an optical axis of the light emitting device **10**; an optical path changer part **30**; an object-side surface **40**; a re-reflection surface **60**; an image formation part **70**; and a light receiver part **80** including a plurality of pixels that form an image by using light transmitted through the image formation part **70** and a main body **100** integrally formed with an assembly guide **90**.

The main body **100** may include: the optical path changer part **30** guiding the path of light emitted from the light emitting device **10**, to the object-side surface **40**; the object-side surface **40** contacting the object **50** and totally reflecting the light emitted from the light emitting device **10**; the re-reflection surface **60** totally re-reflecting the light totally reflected from the object-side surface **40**, to the image formation part **70**; the image formation part **70** collecting the light totally reflected from the object-side surface **40**, and transmitting the light; and the assembly guide **90** guiding an assembly position of the main body **100**.

The light emitting device **10** is a component that emits light for sensing the object **50**. A device such as a light emitting diode (LED) chip may be used as the light emitting device **10**, and a blue LED may be used in the current embodiment. A blue LED has high brightness and thus can effectively have a high contrast ratio. An LED may be used in a package form. An LED package may include: a mounting substrate on which an LED chip is placed; and an encapsulant **12** for protecting the LED chip from the outside. The encapsulant **12** may be an insulating resin having high light transmittance, including epoxy or silicone. A fluorescent substance and/or a dispersing agent may be included in the encapsulant **12**.

The condensing lens **20** is disposed on the optical axis of the light emitting device **10** to collect light emitted from the light emitting device **10** and emit the light in parallel to the optical axis of the light emitting device **10**. Since a typical LED has an orientation angle of about 45° or greater, a light collection efficiency for a typical LED is decreased. Thus, the condensing lens **20** such as a Fresnel lens collects a light flux scattered from an LED, in one direction, thereby improving the light collection efficiency for the LED.

The Fresnel lens used as the condensing lens **20** has a plurality of concentric Fresnel patterns. The concentric Fresnel patterns are designed to have a saw-toothed cross section. Thus, light is incident to the concentric Fresnel patterns and is totally reflected, whereby an orientation angle thereof is adjusted. The concentric Fresnel patterns are also designed such that after light emitted from the light emitting device **10** is incident to the concentric Fresnel patterns and is totally reflected, the light is emitted in parallel to the optical axis.

The main body **100** may be formed of a light transmitting material. The optical path changer part **30**, the object-side surface **40**, the re-reflection surface **60**, the image formation part **70**, and the assembly guide **90** may be integrally formed with corresponding portions of the main body **100**. The main body **100** may be formed of poly methyl methacrylate (PMMA), but is not limited thereto. Thus, a material used to form the main body **100** may be selected from various optical polymers. Light emitted from the light emitting device **10** may be incident into the main body **100** through the optical path changer part **30**, and be emitted from the image formation part **70** via the object-side surface **40** and the re-reflection surface **60**.

The optical path changer part **30** changes a propagation path of light emitted from the light emitting device **10**, toward the object-side surface **40**. Accordingly, an incident angle equal to or greater than a critical angle is formed between the propagation path and the object-side surface **40**, so that the light can be totally reflected from the object-side surface **40**. Thus, light is totally reflected from the object-side surface **40**, to thereby form an image. To this end, light emitted from the light emitting device **10** should be incident to the object-side surface **40** at an angle such that the light is totally reflected from the object-side surface **40**. That is, light should be incident to the object-side surface **40** at the critical angle or greater. Thus, the path of light emitted from the light emitting device **10** is changed by the optical path changer part **30** and is incident to the object-side surface **40** at the critical angle or greater.

Referring to FIG. **2**, the optical path changer part **30** includes: reflective surfaces **34** on which a reflective coating layer **32** is formed; and refractive surfaces **36** having no reflective coating layer. The reflective coating layer **32** may be formed by depositing a metal such as aluminum. Since the reflective coating layer **32** is formed on the optical path changer part **30**, light emitted from the light emitting device **10** is reflected from the reflective surface **34**. Since the reflective coating layer **32** is not formed on the refractive surface **36**, the light emitted from the light emitting device **10** is not reflected from the refractive surface **36** and is transmitted thereby. That is, light emitted from the light emitting device **10** rectilinearly propagates and is reflected from the reflective surface **34** at a reflection angle equal to an incidence angle. Then, the light rectilinearly propagates again in a reflection direction and is refracted at a predetermined angle by the refractive surface **36**. Then, the light arrives at the object-side surface **40**. At this point, an incidence angle of the light is equal to or greater than the critical angle that satisfies a total reflection condition. The critical angle is determined according to a relation between the refractivity of air and the refractivity of a material used to form the object-side surface **40**. The reflective surfaces **34** and refractive surfaces **36** of the optical path changer part **30** may be designed such that the incidence angle of light to the object-side surface **40** is equal to or greater than the critical angle. Light that is not reflected from the reflective surface **34** may be directly incident to the refractive surface **36** of the optical path changer part **30** on which the reflective coating layer **32** is not formed. In this case, the light is refracted only, and thus is incident to the object-side surface **40** at the critical angle or smaller. Accordingly, the light is not totally reflected from the object-side surface **40**.

The object-side surface **40** contacts the object **50**, and light emitted from the light emitting device **10** is totally reflected or refracted by the object-side surface **40**. Referring to FIG. **3**, when the object **50** contacting the object-side surface **40** has an uneven surface, the object-side surface **40** is divided into a contact region **42** contacting the object **50** and a non-contact region **44** that does not contact the object **50**. A light ray **94** emitted from the light emitting device **10** is totally reflected from the non-contact region **44** and propagates. However, a portion of a light ray **92** arriving at the contact region **42** is absorbed by the object **50** and the other is scattered and reflected. That is, light arriving at the non-contact region **44** is totally reflected and propagates to the image formation part **70**, and light arriving at the contact region **42** is absorbed, refracted, or scattered and thus does not propagate to the image formation part **70**. This is because light is totally reflected from a region of the object-side surface **40** which does not contact the object **50** and contacts an air layer having smaller refractivity than that of the object-side surface **40**, and light is not totally reflected from a region of the object-side surface **40** which contacts the object **50** and has greater refractivity than that of the object-side surface **40**.

The light, totally reflected from the object-side surface **40**, is totally reflected to the image formation part **70** by the re-reflection surface **60**. The re-reflection surface **60** may be removed if necessary. In this case, the light totally reflected from the object-side surface **40** directly propagates to the image formation part **70**.

The image formation part **70** collects the light totally reflected from the object-side surface **40** and transmits the light to the light receiver part **80**, and a lens having a short focal length may be used as the image formation part **70** to miniaturize the optical scanning device. The image formation part **70** may include an array lens to correspond to the size of a scan image, and the array lens may have a matrix structure.

The image formation part **70** may be any one of a spherical Fresnel lens, an aspheric Fresnel lens, a spherical lens, and an aspheric lens. In particular, since a lens used as the image formation part **70** has a short focal length to miniaturize the optical scanning device, the lens may be a flat lens such as a hybrid diffraction lens and a multi level lens.

The light receiver part **80** may be an image capturing device that receives, through the image formation part **70**, light totally reflected from the object-side surface **40**, to thereby form an image, and may include a complementary metal oxide semiconductor (CMOS) or charge coupled device (CCD) having a plurality of pixels. Since the light receiver part **80**, forming an image by using the light totally reflected two times by the object-side surface **40** and the re-reflection surface **60**, is inclined from the re-reflection surface **60**, a small image sensor can cope with a large scan region. Although a scan region of the object-side surface **40** has a length of 2.8 mm, the main body **100** has a thickness of 1.5 mm, and the light receiver part **80** has a length of 0.9 mm, thereby miniaturizing the optical scanning device.

In practice, the light totally reflected from the object-side surface **40** and incident to the image formation part **70** may be divided into light perpendicularly incident to the image formation part **70** and light obliquely incident thereto. However, as illustrated in FIG. **4** showing a case that an image is formed on a light receiver part of an optical scanning device according to the present invention, a deviation of incidence angles of the light incident to the image formation part **70** is within ±15 degrees with respect to an optical axis thereof. Thus, the resolution of an image formed on the light receiver part **80** is significantly higher than that of an image formed by a typical light scanning device.

The assembly guide **90** may have a recess shape corresponding to the shape of a guide protrusion that may be formed on a substrate, so that the main body **100** can be efficiently coupled to the substrate. The optical path changer part **30**, the object-side surface **40**, the re-reflection surface **60**, and the image formation part **70** may be integrally formed with the main body **100**, whereas the light emitting device **10**, the condensing lens **20**, and the light receiver part **80** may be separately formed from the main body **100**. When the light emitting device **10** is separately formed from the main body **100**, the light emitting device **10**, the condensing lens **20**, the optical path changer part **30**, the image formation part **70**, and the light receiver part **80** should be aligned with one another. To simplify the aligning and improving the accuracy thereof, the condensing lens **20** is located in an appropriate position on a substrate having a guide protrusion, and then, the main body **100** is coupled to the substrate to insert the guide protrusion into the recess of the main body **100**.

Scattered and reflected light without being totally reflected from the object-side surface **40** may negatively affect a formation of an image of the object **50**. In this case, the assembly guide **90** functions as a barrier for preventing such scattered and reflected light from being incident to the image formation part **70**. Light scattered and reflected by regions of the object-side surface **40** which do not contact the object **50** is prevented from being incident to the image formation part **70** by the assembly guide **90**, thereby improving the resolution of an image of the object **50** formed on the light receiver part **80**.

Hereinafter, an operation of the optical scanning device will now be described with reference to the above-described components.

Light emitted from the light emitting device **10** is collected by the condensing lens **20** and propagates in parallel to the optical axis of the light emitting device **10**. Then, the light is reflected and refracted by the optical path changer part **30** and the path thereof is changed. Accordingly, the light is incident to the object-side surface **40** at the critical angle or greater. Among the incident light, light incident to the contact region **42** contacting the object **50** is absorbed and scattered, and light incident to the non-contact region **44** is totally reflected and propagates. The light ray **94** totally reflected from the object-side surface **40** is totally reflected again to the image formation part **70** by the re-reflection surface **60**, and the image formation part **70** transmits the light ray **94** to the light receiver part **80** to form an image thereon.

As a result, the light totally reflected from the object-side surface **40** is used to form the image on the light receiver part **80**. Since the total reflection from the object-side surface **40** occurs on the non-contact region **44**, the light incident to the light receiver part **80** includes information about regions of the object **50** which do not contact the object-side surface **40**. That is, referring to FIGS. **5**A and **5**B, a region of the object-side surface **40** contacting air instead of the object **50** is sensed as a bright region by the light receiver part **80**, and a region of the object-side surface **40** contacting the object **50** such as a human skin is sensed as a dark region by the light receiver part **80** since light is not totally reflected from the region of the object-side surface **40**. Thus, the region of the object-side surface **40** contacting the object **50** is expressed as a reversal image in the image of the object **50**.

The light ray **92** that is refracted and scattered by the object-side surface **40** is not employed to form an image, and the light ray **94** that is totally reflected by the object-side surface **40** is employed to form an image. According to the current embodiment, since total reflection is used instead of typical scattered reflection, the loss of light emitted from the light emitting device **10** is minimized, thereby obtaining a high contrast ratio that improves the resolution of a scan image. Furthermore, when a blue LED is used as the light emitting device **10**, the high contrast ratio can be maximized.

When the object **50** is a finger, a finger can be scanned to form a fingerprint. When the object **50** is a micro bar code, the micro bar code can be scanned. However, the application of the optical scanning device is not limited thereto, and thus, the optical scanning device may be applied to various devices such as an optical pointing device.

In particular, the optical scanning device may be applied to an optical pointing device by linking the optical scanning device to a display device. Referring to FIG. **6**, an optical pointing device including the optical scanning device may further include: a calculation part **110** that detects a movement of an object by using an image formed at the light receiver part, to calculate a coordinate value; and a display part **120**, that is, a display device, which displays a pointer according to the calculated coordinate value. Under the above configuration, when a finger of a user is moved on the object-side surface, the calculation part **110** calculates, based on information about an image formed at the light receiver part, a moving direction of the finger, a moving speed of the finger, and whether the finger is moved, so as to determine coordinate value. The display part **120** connected to the calculation part **110** displays the pointer on a screen according to the movement of the finger, based on the coordinate value. Since an optical scanning device according to the present invention is smaller and slimmer than a typical optical scanning device, an optical scanning device according to the present invention is suitable for a miniaturized mobile communication terminal such as a smart phone, and a game terminal.

Until now, preferred embodiments of the present invention are described mainly. It will be understood by those skilled in the art that various modifications, changes, and replacements may be made therein without departing from the spirit and scope of the invention. Thus, the preferred embodiments should be considered in descriptive sense only and not for purposes of limitation. The scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope will be construed as being included in the present invention.

The invention claimed is:

1. An ultra thin optical scanning device for a portable information device, comprising:

- a light emitting device that emits light for sensing an object;
- a condensing lens that collects the light emitted from the light emitting device and emits the light in parallel to an optical axis of the light emitting device, and has a plurality of concentric Fresnel patterns;
- an object-side surface contacting the object and totally reflecting the light emitted from the light emitting device;
- an optical path changer part having reflective surfaces with a reflective coating layer formed thereon and refractive surfaces having no reflective coating layer, the optical path changer part guiding a path of the light emitted from the light emitting device to the object-side surface;
- an image formation part collecting the light totally reflected by the object-side surface, and transmitting the light; and
- a light receiver part forming an image by using the light transmitted by the image formation part,
- wherein the light which is reflected from the reflective surface arrives at the object-side with an incidence angle which is equal to or greater than a critical angle,
- wherein the light which is not reflected from the reflective surface arrives at the object-side with an incidence angle which is smaller than the critical angle, and
- wherein the critical angle satisfies a total reflection condition, and
- wherein the incidence angle of the light totally reflected by the object-side surface and collected by the image formation part is within 15° based on an optical axis.

2. The ultra thin optical scanning device of claim **1**, wherein the condensing lens is a Fresnel lens.

3. The ultra thin optical scanning device of claim **1**, wherein the light guided to the object-side surface by the optical path changer part forms an incidence angle such that the light is totally reflected from the object-side surface.

4. The ultra thin optical scanning device of claim **1**, wherein the light emitting device is a light emitting diode (LED).

5. The ultra thin optical scanning device of claim **4**, wherein the LED is a blue LED.

6. The ultra thin optical scanning device of claim **1**, further comprising a re-reflection surface that totally reflects the light totally reflected by the object-side surface to the image formation part.

7. The ultra thin optical scanning device of claim **1**, wherein the image formation part is a Fresnel lens.

8. The ultra thin optical scanning device of claim **1**, wherein the image formation part is an array lens.

9. The ultra thin optical scanning device of claim **1**, wherein the object-side surface, the image formation part, and the optical path changer part are integrally formed with a main body.

10. The ultra thin optical scanning device of claim **6**, wherein the object-side surface, the image formation part, and the re-reflection surface are integrally formed with a main body.

11. The ultra thin optical scanning device of claim **9**, wherein an assembly guide is disposed in a side portion of the main body.

12. An ultra thin optical pointing device for a portable information device, comprising:

a light emitting device that emits light for sensing an object;

a condensing lens that collects the light emitted from the light emitting device and emits the light in parallel to an optical axis of the light emitting device, and has a plurality of concentric Fresnel patterns;

an object-side surface contacting the object and totally reflecting the light emitted from the light emitting device;

an optical path changer part having reflective surfaces with a reflective coating layer formed thereon and refractive surfaces having no reflective coating layer, the optical path changer part guiding a path of the light emitted from the light emitting device to the object-side surface;

an image formation part collecting the light totally reflected by the object-side surface, and transmitting the light;

a light receiver part forming an image by using the light transmitted by the image formation part;

a calculation part detecting a movement of the object by using the image, to calculate a coordinate value; and

a display part displaying a pointer according to the calculated coordinate value,

wherein the light which is reflected from the reflective surface arrives at the object-side with an incidence angle which is equal to or greater than a critical angle,

wherein the light which is not reflected from the reflective surface arrives at the object-side with an incidence angle which is smaller than the critical angle, and

wherein the critical angle satisfies a total reflection condition, and

wherein the incidence angle of the light totally reflected by the object-side surface and collected by the image formation part is within 15° based on an optical axis.

13. The ultra thin optical pointing device of claim **12**, further comprising a re-reflection surface that totally reflects the light totally reflected by the object-side surface, to the image formation part.

14. The ultra thin optical pointing device of claim **12**, wherein the object-side surface, the image formation part, and the optical path changer part are integrally formed with a main body.

15. The ultra thin optical pointing device of claim **13**, wherein the object-side surface, the image formation part, and the re-reflection surface are integrally formed with a main body.

16. The ultra thin optical scanning device of claim **10**, wherein an assembly guide is disposed in a side portion of the main body.

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